

What is claimed is:

1. A composition comprising a lithium fluoride compound demonstrating a specific capacity of about 100 mAh/g to about 700 mAh/g at a voltage of about 2 volts to about 5 volts.
2. The composition of claim 1, further comprising elemental carbon.
3. The composition of claim 1, further comprising an elemental metal.
4. The composition of claim 3, wherein the elemental metal is Fe, Co, Ni, Mn, Cu, V, Mo, Pb, Sb, Bi, or Si.
5. The composition of claim 1, wherein the specific capacity is reversible.
6. The composition of claim 1, wherein the composition demonstrates a specific capacity about 550 mAh/g to about 700 mAh/g.
7. The composition of claim 1, wherein the lithium fluoride compound comprises LiF.
8. The composition of claim 1, wherein the lithium fluoride compound comprises a compound of the formula Li_yMeF_x where Me is a metal and wherein the values of y and x are such that, based on the oxidation state of metal Me, the lithium fluoride compound is neutral.
9. The composition of claim 8, wherein the Me is a transition metal.
10. The composition of claim 8, wherein the Me is Fe, Co, Ni, Mn, Cu, V, Mo, Pb, Sb, Bi, or Si.
11. The composition of claim 8, wherein the lithium fluoride compound comprises LiFeF_3 .
12. The composition of claim 1, wherein the lithium fluoride compound comprises particles of about 1 nm to about 100 nm.
13. The composition of claim 1, wherein the lithium fluoride compound comprises particles of about 1 nm to about 50 nm.
14. The composition of claim 1, wherein the lithium fluoride compound comprises particles of about 2 nm to about 30 nm.
15. The composition of claim 1, wherein the lithium fluoride compound comprises particles of about 2 nm to about 15 nm.

16. A composition comprising particles of about 1 nm to about 100 nm, wherein the particles comprise a lithium fluoride compound.
17. The composition of claim 16, further comprising elemental carbon.
18. The composition of claim 16, wherein the particles are of about 1 nm to about 50 nm.
19. The composition of claim 16, wherein the particles are of about 2 nm to about 30 nm.
20. The composition of claim 16, wherein the particles are of about 2 nm to about 15 nm.
21. The composition of claim 16, wherein the lithium fluoride compound comprises LiF.
22. The composition of claim 16, wherein the lithium fluoride compound comprises a compound of the formula Li_yMeF_x where Me is a metal and wherein the values of y and x are such that, based on the oxidation state of metal Me, the lithium fluoride compound is neutral.
23. The composition of claim 22, wherein the Me is a transition metal.
24. The composition of claim 22, wherein the Me is Fe, Co, Ni, Mn, Cu, V, Mo, Pb, Sb, Bi, or Si.
25. The composition of claim 22, wherein the lithium fluoride compound comprises LiFeF_3 .
26. The composition of claim 16, further comprising an elemental metal.
27. The composition of claim 26, wherein the elemental transition metal is Fe, Co, Ni, Mn, Cu, V, Mo, Pb, Sb, Bi, or Si.
28. The composition of claim 16, wherein the composition demonstrates a specific capacity of about 100 mAh/g to about 700 mAh/g at a voltage of about 2 volts to about 5 volts.
29. The composition of claim 28, wherein the specific capacity is reversible.
30. The composition of claim 16, wherein the composition demonstrates a specific capacity about 550 mAh/g to about 700 mAh/g.
31. An electrochemical cell comprising: (a) negative electrode; (b) a positive electrode comprising a lithium fluoride compound; and (c) a separator disposed between the negative and positive electrodes, wherein the electrochemical cell demonstrates a specific capacity of about 100 mAh/g to about 700 mAh/g at a voltage of about 2 volts to about 5 volts.

32. The electrochemical cell of claim 31, wherein the positive electrode further comprises elemental carbon.
33. The electrochemical cell of claim 31, wherein the specific capacity is reversible.
34. The electrochemical cell of claim 31, wherein the specific capacity is about 550 mAh/g to about 700 mAh/g.
35. The electrochemical cell of claim 31, wherein the lithium fluoride compound comprises LiF.
36. The electrochemical cell of claim 31, wherein the lithium fluoride compound comprises a compound of the formula Li_yMeF_x where Me is a metal and wherein the values of y and x are such that, based on the oxidation state of metal Me, the lithium fluoride compound is neutral.
37. The electrochemical cell of claim 36, wherein the Me is a transition metal.
38. The electrochemical cell of claim 36, wherein the Me is Fe, Co, Ni, Mn, Cu, V, Mo, Pb, Sb, Bi, or Si.
39. The electrochemical cell of claim 36, wherein the lithium fluoride compound comprises LiFeF_3 .
40. The electrochemical cell of claim 31, wherein the positive electrode further comprises an elemental metal.
41. The electrochemical cell of claim 40, wherein the elemental metal is Fe, Co, Ni, Mn, Cu, V, Mo, Pb, Sb, Bi, or Si.
42. The electrochemical cell of claim 31, wherein the positive electrode comprises particles of about 1 nm to about 100 nm and the particles comprise the lithium fluoride compound.
43. The electrochemical cell of claim 42, wherein the particles are of about 1 nm to about 50 nm.
44. The electrochemical cell of claim 42, wherein the particles are of about 2 nm to about 30 nm.
45. The electrochemical cell of claim 42, wherein the particles are of about 2 nm to about 15 nm.

46. The electrochemical cell of claim 31, further comprising a lithium metal negative electrode.
47. An electrochemical cell comprising: (a) negative electrode; (b) a positive electrode comprising particles of about 1 nm to about 100 nm, wherein the particles comprise a lithium fluoride compound; and (c) a separator disposed between the negative and positive electrodes.
48. The electrochemical cell of claim 47, wherein the particles further comprise elemental carbon.
49. The electrochemical cell of claim 47, wherein the particles are of about 1 nm to about 50 nm.
50. The electrochemical cell of claim 47, wherein the particles are of about 2 nm to about 30 nm.
51. The electrochemical cell of claim 47, wherein the particles are of about 2 nm to about 15 nm.
52. The electrochemical cell of claim 47, wherein the positive electrode further comprises an elemental metal.
53. The electrochemical cell of claim 52, wherein the elemental transition metal is Fe, Co, Ni, Mn, Cu, V, Mo, Pb, Sb, Bi, or Si.
54. The electrochemical cell of claim 47, wherein the electrochemical cell demonstrates a specific capacity of about 100 mAh/g to about 700 mAh/g at a voltage of about 2 volts to about 5 volts.
55. The electrochemical cell of claim 54, wherein the specific capacity is reversible.
56. The electrochemical cell of claim 54, wherein the specific capacity is about 550 mAh/g to about 700 mAh/g.
57. The electrochemical cell of claim 47, wherein the lithium fluoride compound comprises LiF.
58. The electrochemical cell of claim 47, wherein the lithium fluoride compound comprises a compound of the formula Li_yMeF_x where Me is a metal and wherein the values of y and x are such that, based on the oxidation state of metal Me, the lithium fluoride compound is neutral.

- 59. The electrochemical cell of claim 58, wherein the Me is a transition metal.
- 60. The electrochemical cell of claim 58, wherein the Me is Fe, Co, Ni, Mn, Cu, V, Mo, Pb, Sb, Bi, or Si.
- 61. The electrochemical cell of claim 58, wherein the lithium fluoride compound comprises LiFeF_3 .
- 62. The electrochemical cell of claim 58, wherein the lithium fluoride compound comprises LiFeF_3 .
- 63. The electrochemical cell of claim 47, wherein the lithium fluoride compound LiFeF_3 .
- 64. The electrochemical cell of claim 47, further comprising a lithium metal negative electrode.